Claims

What is claimed is:

1. A method, comprising:

directing a probe beam from an optical probe located above a surface of a wafer to the surface of the wafer;

using an optical alignment structure on the wafer to direct a portion of the probe beam along a direction above the wafer; and

using the portion of the probe beam from the optical alignment structure as a guide to adjust a position of the optical probe relative to the optical alignment structure.

2. The method as in claim 1, further comprising using the optical probe to collect the portion of the probe beam.

3. The method as in claim 1, further comprising using a different device above the wafer to collect the portion of the probe beam.

4. The method as in claim 1, wherein the optical probe comprises a fiber having an angled end facet, the method further comprising tilting the fiber relative to the normal direction of the surface of the wafer.

5. The method as in claim 1, further comprising using a control feedback loop to control the relative position between the optical probe and the wafer according to an amount of the portion of the probe beam from the optical alignment structure.

6. The method as in claim 1, further comprising using an optically reflective dot as the optical alignment structure.

7. The method as in claim 1, further comprising using a combination of a reflective dot and a reflective line adjacent to the dot as the optical alignment structure.

8. The method as in claim 7, further comprising using light from the reflective line as a guide to adjust the optical probe relative to the wafer to a location near the dot where light from the dot can be detected.

9. The method as in claim 8, further comprising: after the light from the dot is detected, scanning a position of the optical probe relative to the dot to find the location where the light from the dot is maximized.

10. The method as in claim 9, further comprising scanning the optical probe in a circular path to place the dot at the center of the circular path according to the light from the dot received by the optical probe.

11. The method as in claim 1, further comprising using an optical grating as the optical alignment structure.

12. The method as in claim 11, wherein the optical grating is a Littrow grating fabricated on the surface of the wafer.

13. The method as in claim 12, further comprising using at least one fiber in the optical probe to direct the probe beam to the wafer and to collect the portion of the probe beam returning to the fiber probe.

14. The method as in claim 13, further comprising using a single mode fiber as the fiber.

15. The method as in claim 13, further comprising using a polarization maintaining fiber as the fiber.

16. The method as in claim 13, further comprising using a multi-mode fiber as the fiber.

17. The method as in claim 1, further comprising:

using the optical alignment structure as a guide to move the wafer to place the optical probe to a first location above the wafer; and

using a positional relationship between the first location and a selected location on the wafer to move the wafer to position the optical probe from the first location to the selected location above the wafer.

18. The method as in claim 17, further comprising using the optical probe to conduct an optical test on a component located at the selected location.

19. The method as in claim 1, wherein the optical alignment mark surrounds a selected location on the wafer and has a spatially varying reflectivity profile, the method further comprising:

adjusting a relative position between the optical probe and the wafer to find optical reflection from the optical alignment structure;

adjusting the optical probe relative to the optical alignment structure to use a spatial variation of the optical

reflection to determine a relative position between the optical probe and the selected location; and

using the spatially varying reflectivity profile as a guide to direct the optical probe to the selected location.

20. The method as in claim 1, further comprising using an optical component connected to an optical waveguide on the wafer as the optical alignment structure.

21. The method as in claim 20, wherein the optical component is responsive to the probe beam to cause an electronic signal to be generated on the wafer, and the method further comprising using an electronic probe to contact the wafer to receive the electronic signal from the wafer.

22. The method as in claim 20, wherein the optical component is responsive to the probe beam to cause an optical signal to be generated on the wafer and directed above the wafer, and the method further comprising collecting the optical signal at a location above the from the wafer.

23. The method as in claim 22, wherein the optical probe is used to collect the optical signal.

24. The method as in claim 22, wherein an optical collector above the wafer and different from the optical probe is used to collect the optical signal.

25. The method as in claim 1, wherein the optical probe comprises at least one fiber, the method further comprising using one of (1) a single-mode fiber, (2) a polarization maintaining fiber, and (3) a multi-mode fiber as the fiber.

26. The method as in claim 1, wherein the optical probe comprises a fiber array having a plurality of fibers, the method further comprising:

using one fiber in the fiber array to direct the probe beam to the wafer; and

using an output from the wafer produced in response to the probe beam to align other fibers in the fiber array to respective optical components on the wafer.

27. The method as in claim 26, wherein the output is an optical signal originated from the probe beam, the method further comprising using the one fiber for directing the probe beam to receive the output.

28. The method as in claim 26, wherein the output includes an electrical signal caused by the probe beam.

29. The method as in claim 26, further comprising using at least one single mode fiber as one of the fibers in the fiber array.

30. The method as in claim 26, further comprising using at least one multi-mode fiber as one of the fibers in the fiber array.

31. The method as in claim 26, further comprising using at least one polarization maintaining fiber as one of the fibers in the fiber array.

32. The method as in claim 1, further comprising using the optical probe to collect an optical output from the wafer to test an optical component on the wafer.

33. The method as in claim 1, further comprising:

using a known spatial relationship between a position of each component on the wafer relative to the optical alignment structure to align the optical probe with at least one optical component on the wafer; and

using the probe beam from the optical probe to optically test the optical component.

34. The method as in claim 33, further comprising measuring an electrical signal produced on the wafer due to an interaction between an optical component on the wafer and the probe beam.

35. The method as in claim 33, further comprising collecting an output beam from the wafer by using an optical fiber above the wafer and using an optical detector to measure the output beam received by the fiber.

36. The method as in claim 33, further comprising performing wafer-level testing on electronic components on the wafer.

37. The method as in claim 33, further comprising performing wafer-level testing on optical components on the wafer.

38. The method as in claim 33, further comprising performing wafer-level testing on optoelectronic components on the wafer.

39. The method as in claim 33, wherein the optical probe comprises a fiber array of fibers, the method further comprising:

using one fiber in the fiber array to deliver the probe beam to the wafer; and

using the one fiber to receive the portion of the probe beam from the optical alignment structure.

40. The method as in claim 33, wherein the optical probe comprises a fiber array of fibers, the method further comprising:

using one fiber in the fiber array to deliver the probe beam to the wafer; and

using another fiber in the fiber array to receive the portion of the probe beam from the optical alignment structure.

41. The method as in claim 33, wherein the optical probe comprises a fiber array of fibers, the method further comprising:

using at least two fibers in the fiber array to deliver two different probe beams to two optical components the wafer to optically test the two optical components.

42. The method as in claim 1, wherein the optical probe includes at least one fiber, the method further comprising:

using a known spatial relationship between a position of an optical port on the wafer relative to the optical alignment structure to align the fiber with the optical port;

bringing the fiber in contact with the optical port; and

applying an adhesive to bond the fiber to the optical port.

43. The method as in claim 1, the optical probe includes an array of fibers corresponding to an array of optical ports on the wafer, the method further comprising:

aligning the fibers to the optical ports, respectively;

bringing the fibers in contact with the optical ports, respectively; and

applying an adhesive to bond each fiber to a corresponding optical port.

44. A device, comprising:

a wafer having a wafer surface patterned to comprise an integrated component and an optical coupler, the optical coupler operable to couple light incident from a device above the wafer into the integrated component; and

at least one optical alignment structure on the wafer surface and spatially separated from the optical coupler with a

predetermined spatial offset, the optical alignment structure operable to direct at least a portion of incident light along a predetermined direction above the wafer surface to optically mark a relative position of the optical coupler.

45. The device as in claim 44, wherein the optical alignment structure is optically retro-reflective.

46. The device as in claim 44, wherein the optical alignment structure comprises an optical grating.

47. The device as in claim 44, wherein the optical grating is a Littrow grating.

48. The device as in claim 44, wherein the optical alignment structure is shaped as a dot.

49. The device as in claim 48, further comprising a second optical alignment structure having a line shape located relative to the dot.

50. The device as in claim 44, wherein the wafer further comprises an integrated electronic circuit element on the wafer surface.

51. The device as in claim 44, wherein the optical alignment structure comprises an optical device on the wafer.

52. The device as in claim 51, wherein the optical device comprises a waveguide and at least one optical coupler engaged to one end of the waveguide to couple light incident from a device above the wafer into the waveguide.

53. The device as in claim 44, wherein the optical coupler comprises a grating coupler.

54. The device as in claim 44, wherein the integrated component comprises a waveguide.

55. The device as in claim 44, wherein the integrated component comprises an optical detector.

56. The device as in claim 44, wherein the integrated component comprises an optical modulator.

57. The device as in claim 44, wherein the integrated component comprises an optical wavelength division multiplexer.

58. The device as in claim 44, wherein the integrated component comprises an arrayed waveguide grating.

59. The device as in claim 44, wherein the integrated component comprises an optical switch.

60. The device as in claim 44, wherein the integrated component comprises an optical directional coupler.

61. The device as in claim 44, wherein the integrated component comprises an optical splitter.

62. The device as in claim 44, wherein the integrated component comprises an optical amplifier.

63. The device as in claim 44, wherein the integrated component comprises an optical attenuator.

64. The device as in claim 44, wherein the wafer is patterned to comprise a plurality of dice, wherein at least one die is patterned to comprise the integrated component and the optical coupler and to further comprise an integrated electronic circuit.

65. The device as in claim 64, wherein the integrated electronic circuit controls an operation of the integrated component.

66. The device as in claim 44, wherein the optical alignment structure comprises an optical waveguide comprising input and output ports that are located adjacent to the integrated component, and wherein the input port comprises an input optical coupler to couple incident light into the optical waveguide and the output port comprises an output optical coupler to couple light out of the output port to optically mark the relative position of the optical coupler.

67. The device as in claim 44, wherein the optical alignment structure is an elongated optical alignment line structure, and the device further comprising a second optical alignment structure in a dot shape and spaced from and aligned with the elongated optical alignment line structure.

68. The device as in claim 44, wherein the optical alignment structure has a spatially varying reflectivity profile.

69. A system, comprising:

a wafer holder to hold a wafer comprising dice pattered to include optical devices and optical alignment features that reflect incident light;

a wafer positioner engaged to the wafer holder to control positions and orientations of the wafer;

an optical probe positioned above the wafer holder to deliver a probe beam to the wafer at an incident direction above the wafer and to receive light from an optical alignment feature;

an optical probe positioner engaged to the optical probe to control a position of the optical probe relative to the wafer; and

a control system to control the wafer positioner and the optical probe positioner in aligning the optical probe to a selected position on the wafer at least in part according to light from the optical alignment feature.

70. The system as in claim 69, wherein the optical probe comprises a sensor that measures a spacing between the wafer and the fiber probe.

71. The system as in claim 70, wherein the sensor comprises a capacitance sensor.

72. The system as in claim 69, wherein the optical probe comprises a fiber array of fibers to direct a plurality of probe beams to the wafer.

73. The system as in claim 72, wherein the fiber array comprises at least one fiber dedicated for receiving the light from the optical alignment feature.

74. The system as in claim 72, wherein the optical probe positioner comprises a mechanism to adjust a yaw of the fiber array around an axis perpendicular to the wafer.

75. The system as in claim 69, wherein the optical probe comprises a fiber array of fibers to collect a plurality of output optical beams from the wafer.

76. A method, comprising:

positioning an optical probe head comprising an array of optical waveguides above a wafer;

using at least one optical waveguide in the array to direct a probe beam to the wafer which directs at least a portion of the probe beam back to the array;

using one of the optical waveguides in the array to receive the portion of the probe beam; and

using received light in the one of the optical waveguides as at least one of (1) a guide to adjust a position of the optical probe head relative to a position on the wafer to align different optical waveguides to different predetermined positions on the wafer and (2) a monitor signal to test an optical component on the wafer.

77. The method as in claim 76, wherein the one of the optical waveguides is the same as the optical waveguide to direct the probe beam to the wafer.

78. The method as in claim 76, wherein the one of the optical waveguides is different from the optical waveguide to direct the probe beam to the wafer.

79. The method as in claim 76, further comprising using at least two optical waveguides to direct two probe beams to two different optical ports on the wafer to test two components that are connected to the optical ports to receive the two probe beams, respectively.

80. The method as in claim 76, further comprising using at least two optical waveguides to receive two output optical beams

from two different optical ports on the wafer to test components associated with the two optical ports, respectively.

81. The method as in claim 76, wherein the optical waveguides are fibers, the method further comprising:

aligning the fibers to optical ports on the wafer, respectively, based on at least the received light; and

bring end facets of the fibers to be in contact with the optical ports, respectively; and

applying an adhesive at an interface between an end facet of each fiber and a corresponding optical port to bond the fiber to the optical port.

82. The method as in claim 76, further comprising using at least one multi-mode fiber as one of the optical waveguides.

83. The method as in claim 76, further comprising using at least one single-mode fiber as one of the optical waveguides.

84. The method as in claim 76, further comprising using at least one polarization maintaining fiber as one of the optical waveguides.